NAVAL RESEARCH ADVISORY COMMITTEE

Lighter-Than-Air Systems for Future Naval Missions

Flag Officers
And
Senior Executive Service

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The Pentagon Auditorium

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Naval Air Systems Command

Terms of Reference Objectives

- **Assess applications of LTA technology for the full spectrum of Sea Power 21 missions and for providing capabilities to meet new GWOT**

- **Emphasize:**
  - **Security of naval port/harbor resources**
  - **Force protection from cruise missiles, fast boats, shallow-water submarines and mines**
  - **Global transoceanic and sea-based delivery of cargo**

- ***Sponsors*:**
  - ***Mr. William Balderson, Deputy Assistant Secretary of the Navy (RDA) for Air Programs***
  - ***RDML Jeff Wieringa, Assistant Commander for Research & Engineering, Naval Air Systems Command***

Categories of LTA Vehicles

Balloons

AMS Skyship 600

ABC Lightship A-170

Zeppelin NT
(Semi-Rigid)

Goodyear GZ-22
(Non-Rigid)

Airships

Aerostats
(Tethered)

ATG Sky Kitten

Hybrids

Executive Summary

Conclusions

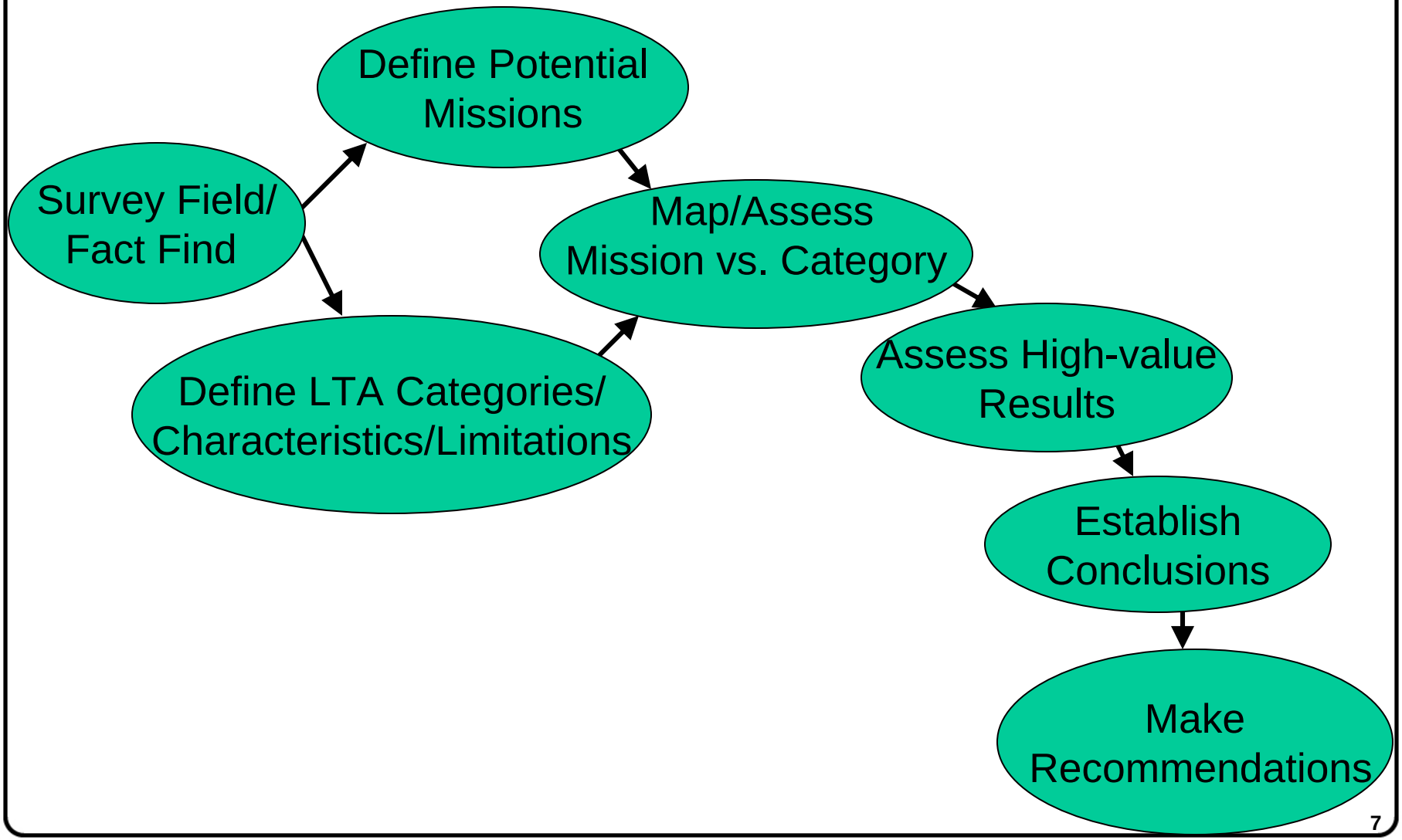
- **LTA vehicles exist that offer enhanced, lower cost capability for persistent ISR, communications relay or electronic warfare capabilities**
  - **- Marine Corps communication relay**
  - **- Port/harbor security**

- **Both persistent high-altitude airships and heavy-lift airships offer desired solutions for future maritime missions, but require significant technology development**

Recommendations

- **Acquire and evaluate capability of aerostats for naval port/harbor security and for Marine Corps communications relay**
- **Develop an aerostat for shipboard operations underway, e.g. LCS**
- **Demonstrate low-altitude, unmanned airship to provide rapid reaction for ISR, communications relay, electronic warfare and other capabilities**
- **Leverage the DARPA ISIS S&T program for the development of a low-power-density, large aperture radar system for application in low-altitude LTA vehicles**
- **Conduct studies to understand how a hybrid/cargo lift prototype vehicle interfaces with future sea-basing concepts, including MPF(F)**

LTA Committee Study Work-flow



LTA Briefings Received

Programs
- JLENS
- TARS
- SASS
- REAP
- RAID
- Combat SkySat
- HATB
- Talon Topper
- HABIT
- ISIS
- WALRUS
- PTDS
- MARTS
- HAA

University
- NMSU
- UCLA

Congress
- HPSCI

Non-Profit
- AIAA

Government Organizations
- OFFICE OF NAVAL RESEARCH
- NAVAIR
- DARPA
- HQMC (I & L)
- MCSC
- NASA Dryden
- US Army G2 & ASA
- CAA (Army)
- USAF (Near Space & Battle Lab)
- DASN-AIR, DASN- RDT&E
- NAVSEA (DEW Office)
- OPNAV/N71
- AF Science Advisory Board (SAB)

Consultants
- Chuck Myers (Hybrid Airships)
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Industry
- Lucent
- Northrop Grumman
- L3 Communications
- Lockheed Martin
- American Blimp Corp
- Raytheon
- Airship Mgt Services
- ILC Dover
- PSL (NMSU)
- TCOM

International
- Zeppelin (GER)
- ATG (UK)
- Selenia/Nautilus (IT)
- Israel MOD
- Japan/JAXA/Sojitz

Navy LTA Background

- **Navy in LTA business from 1917 to 1962**
- **Observation balloons (WWI era)**
- **Non-rigid (“blimps”)--241 acquired**
- **Rigid airships--4 acquired, including the aircraft-carrying *Akron* and *Macon***
- **World War II: 168 blimps operational for coastal patrol and convoy escort**
- **Cold War: 56 blimps procured for ASW and homeland defense AEW**
- **Program ended in 1962 for threat and fiscal reasons**
- **Limited R&D effort 1975-1990**

No currently active LTA programs

Why Renewed Interest in LTA?

- **Threat has changed (from high tech aircraft, missiles to terrorists)**
  - **Need to extend the horizon**
  - **Need persistence**

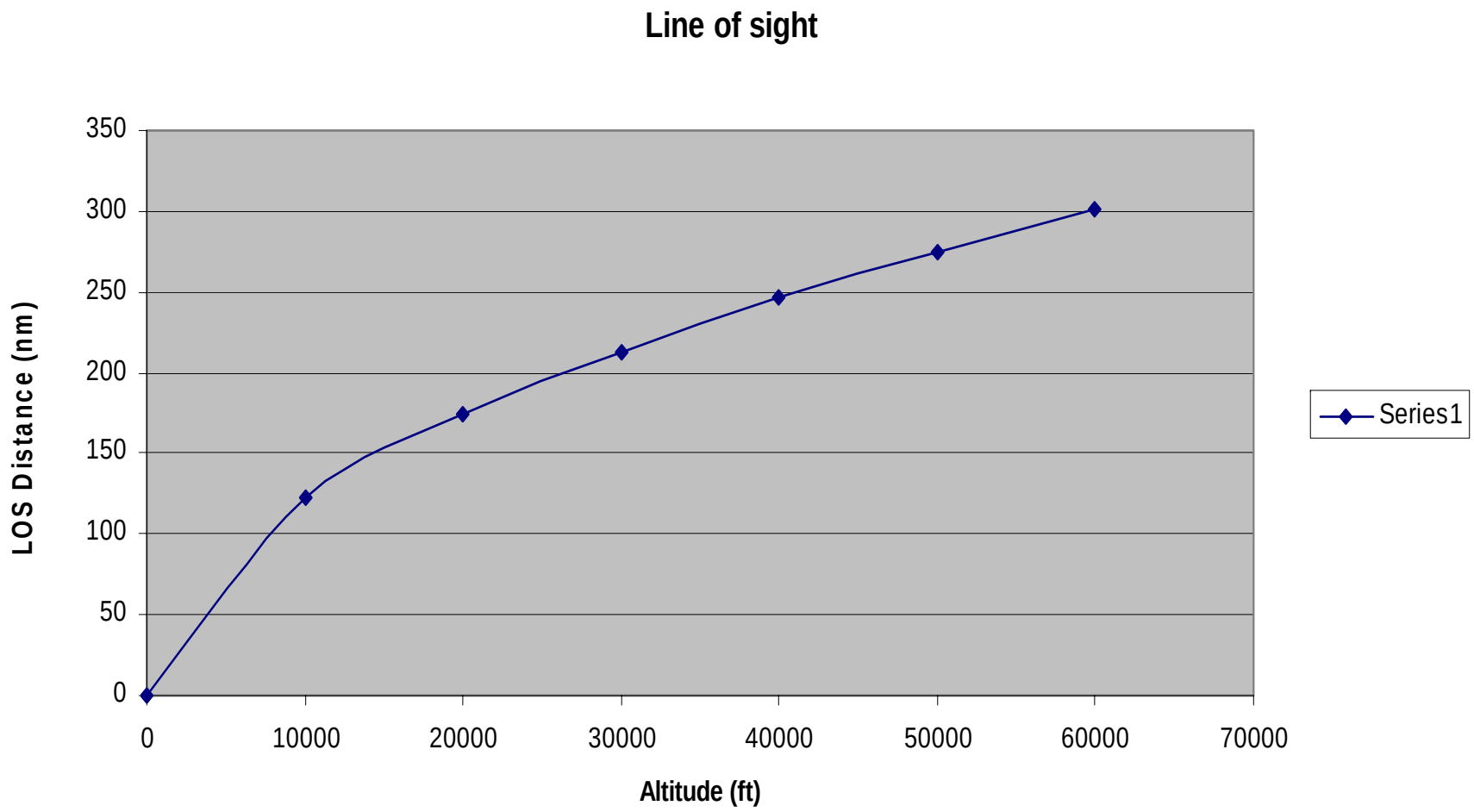
- **With station keeping, LTA provides persistent presence with increased line of sight**
  - **Low altitude (< 10,000 ft) relatively easy**
  - **High altitude (60,000 – 80,000 ft) desired, but difficult**

- **Potential payloads are lighter and more capable**

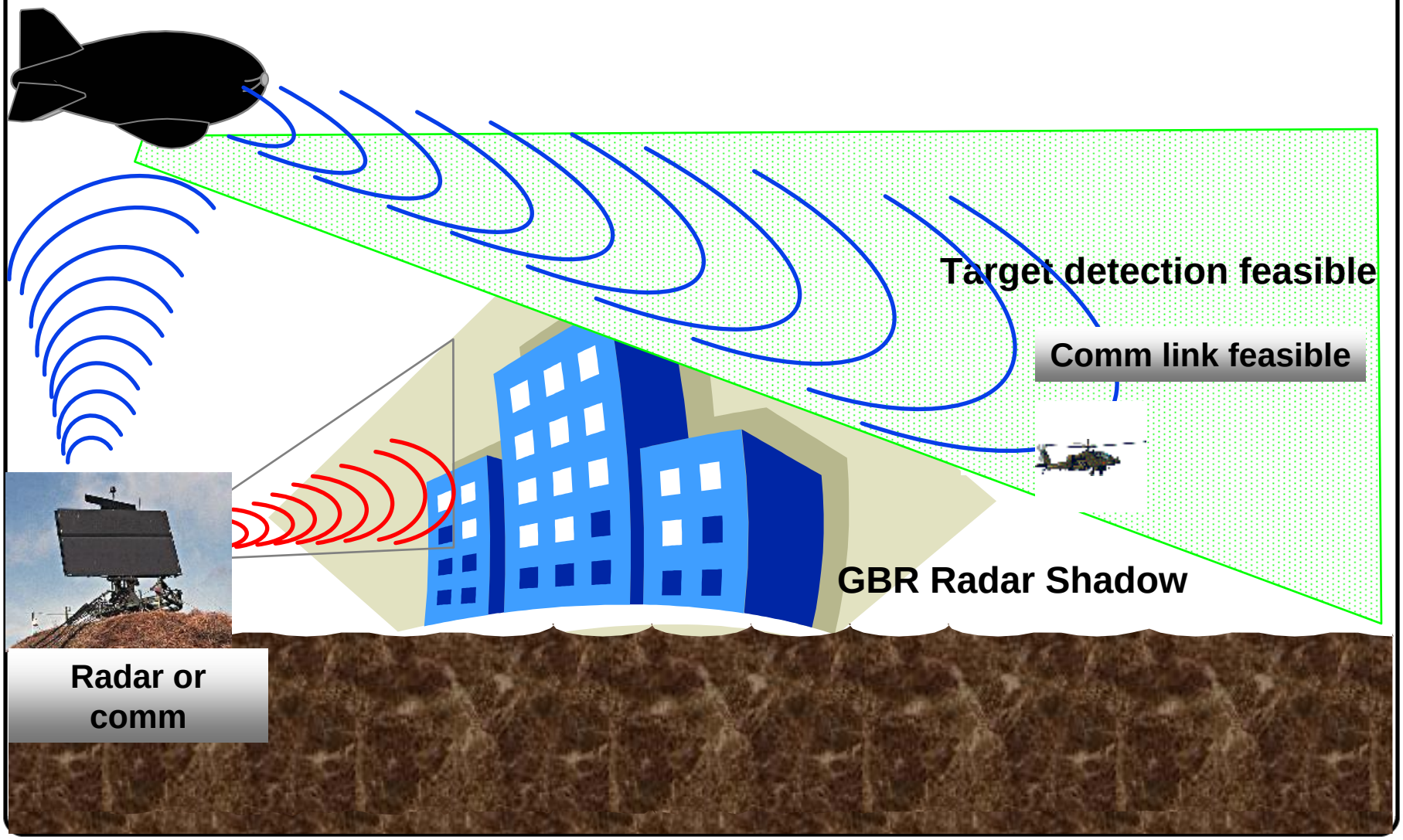
- **Better meteorological prediction capability**

- **Potential to lift and transport very heavy payloads directly to the war fighter**

Line of Sight Distance to Horizon vs Altitude



Surveillance/Comm Relay Enhanced by Altitude

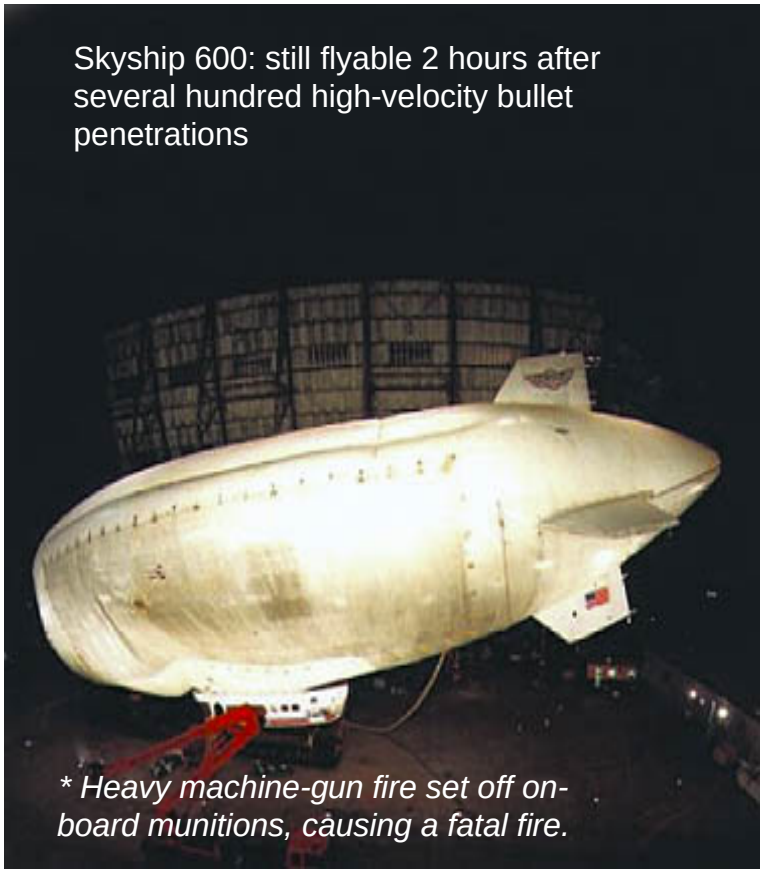


Attributes of LTA Vehicles

- **LTA vehicle volumes are relatively large, potential for very large, internal antennas**
- **Platform nonrecurring costs low relative to aircraft**
- **Operating infrastructure costs potentially low relative to other forms of aviation**
- **Low signatures—acoustic, IR, RF**
- **LTA envelopes are highly survivable**

Airship Envelope Survivability

- **Airship envelopes are highly survivable against conventional threats:**
  - **Gas leaks slowly, even from multiple holes in envelope**
  - **Live-fire testing in U.S. & U.K. confirms survivability**
  - **Recovery likely even after severe damage, as experienced in Iraq**
  - **Missiles unlikely to fuze**

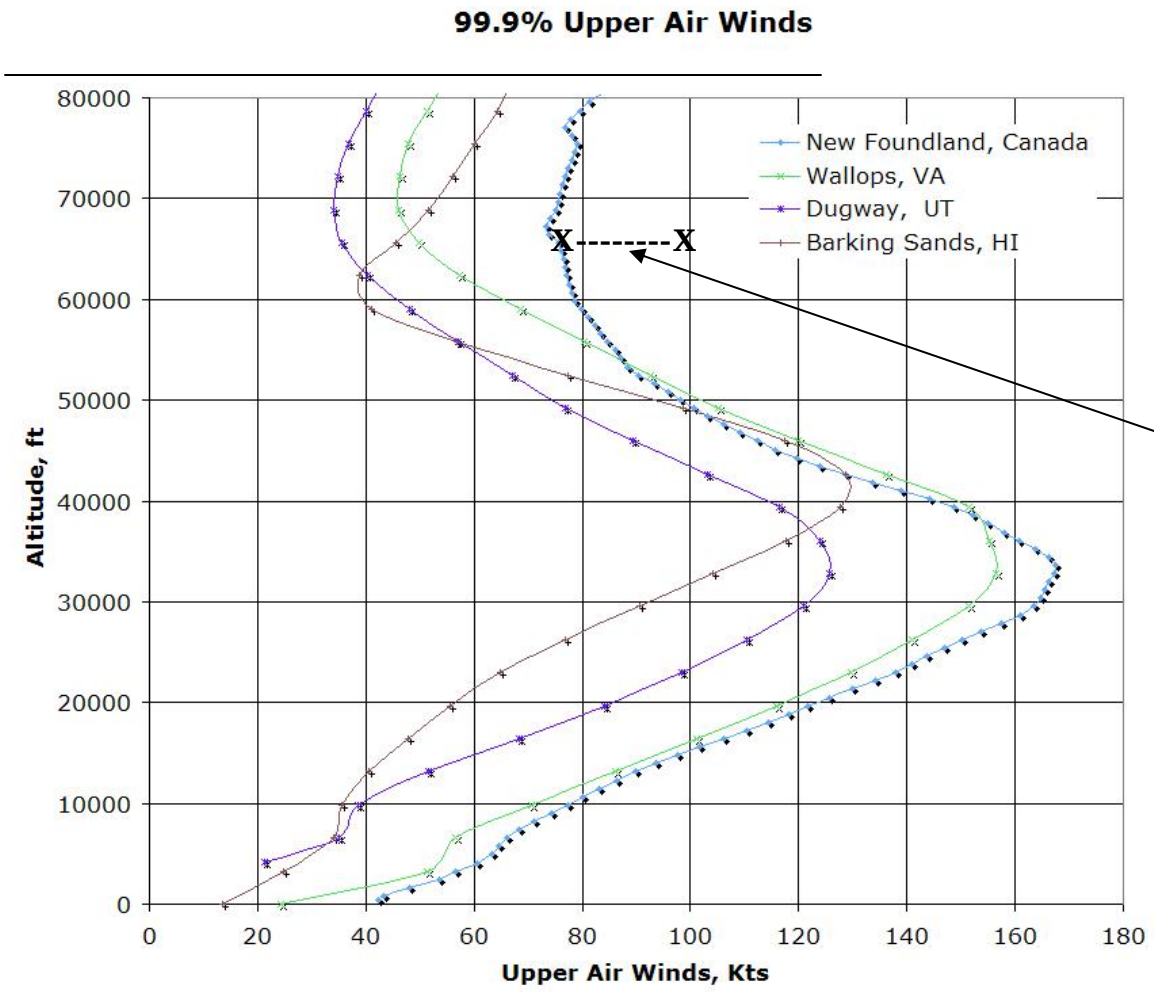


Numerous Examples Show Airships Are Not Easy To Bring Down…

LTA Limitations

- **Airship cruise speed < 80 knots**
  - **Easily visually targeted (Aerostats and low flying airships)**
  - **Airspace deconfliction**
- **Airship and helium infrastructure (hangars and bottles)**
- **LTA vehicles are affected by weather and winds**
  - **Take-offs and landings could be difficult**
  - **Winds affect altitude flight options**

Winds Affect Flight Altitudes



Baghdad, 3-sigma January winds

Source: NASA

Sea-Based Aerostat Systems

Maritime Interdiction and Surveillance Team (MIST) – Coast Guard – 1980's

Small Aerostat Surveillance System (SASS) – Army – 1980's

LTA Today

	Balloons	Aerostats	Airships
Commercial - International & U.S.			
– Tourism			●
– Advertising		●	●
– Communications	●	●	
U.S. Department of Defense			
– Marine Corps COMM in Iraq		●	
– Army Surveillance/force protection in Iraq/Afghanistan		●	
– Air Force Border Surveillance		●	
U.S. Department of Homeland Security			
– Border Patrol		●	
– Detection of low-flying aircraft		●	
– Detection of drug trafficking (aircraft, boats, people)		●	
Israel MOD			
– ISR		●	
– Border surveillance		●	
– Naval surveillance		●	
– Counter terrorism		●	
Other Security Roles			
– NYPD Fleet Week			●
– Olympic Games (Atlanta, Athens)			●

All applications 15,000 ft. or below

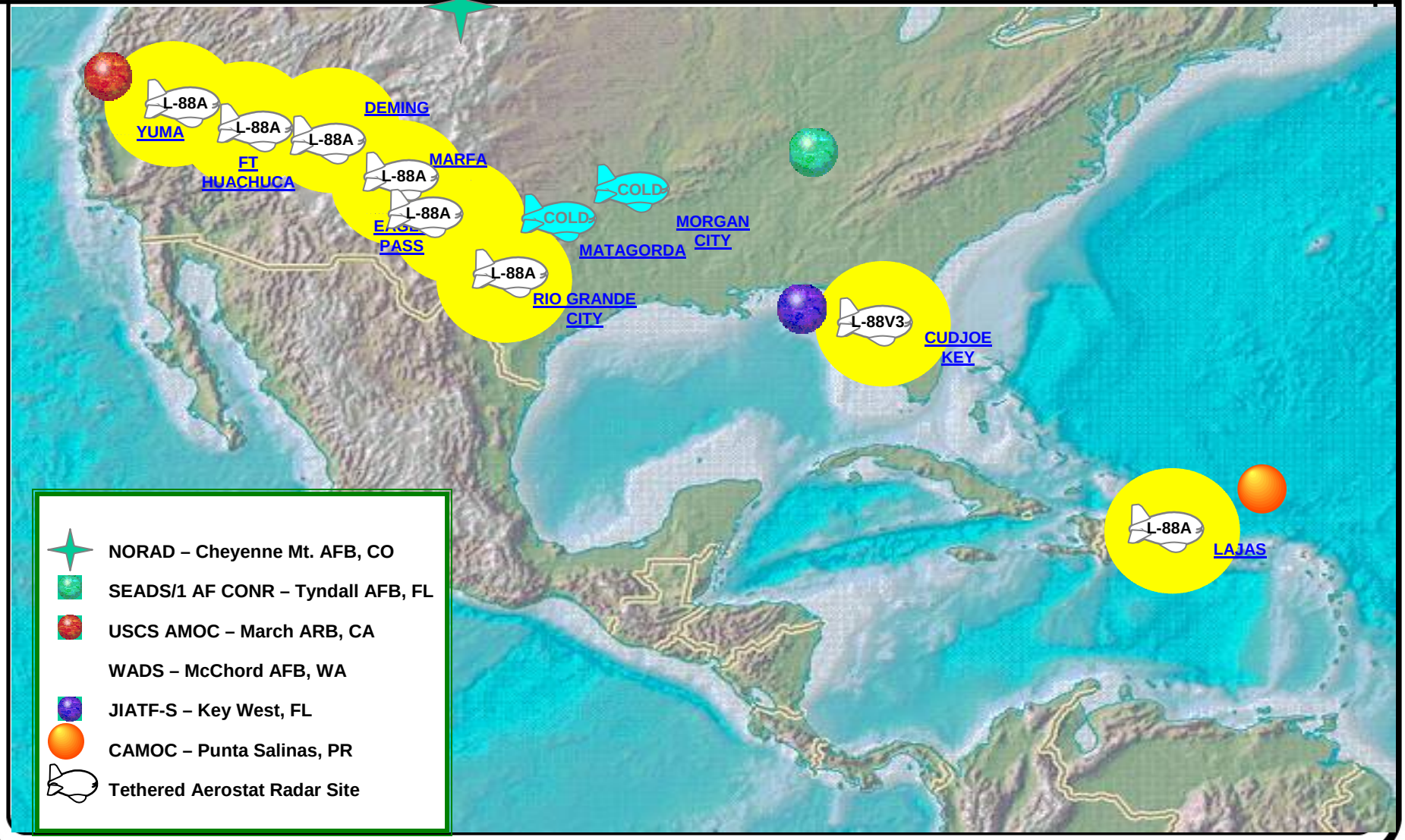
JLENS RAID DEPLOYMENTS

RAID 1 - OEF

RAID 2 –OEF/OIF

Mission: Provide Base Security Cells With Hi-resolution, Day/night Surveillance Capability That Provides Enhanced Target Recognition and Situational Understanding.

Tethered Aerostat Radar System (TARS)
Operating Locations and Customers – AF ACC



NAVAIR Littoral Airborne Sensor Hyperspectral - Lash

Using hyperspectral passive electro-optic sensor, airship tracks whales along east coast

LASH Sees to 51 Feet throughout Year – NASA data

LTA Sensors

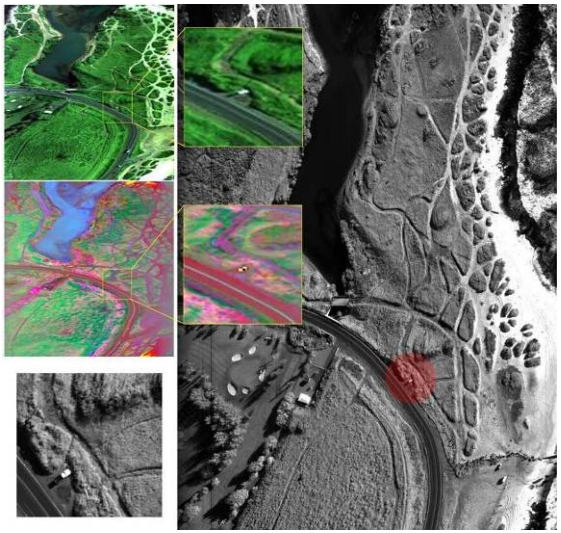
Cineflex

ISR

Mini SAR

ISR

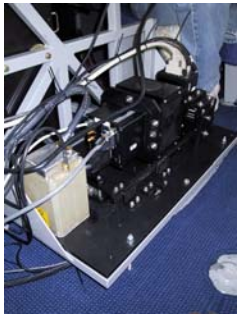
IED



ASW

MCM

IED



Archer (HSI)

Vehicles under camouflage

FLIR

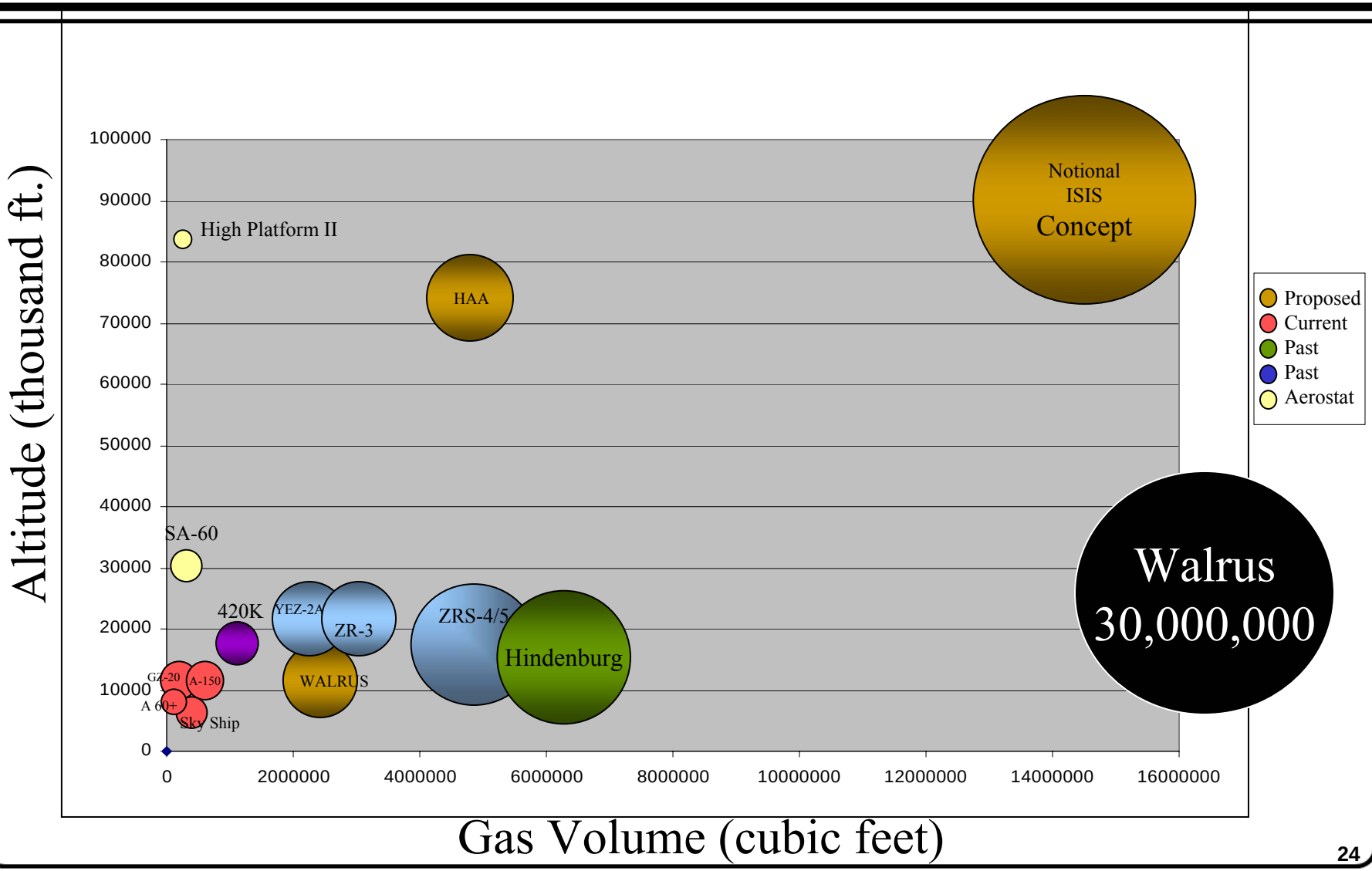
Night Helo landing

POP 300

Existing LTA Vehicle Comparison

	Payload	Endurance	Station Keeping	Line of Sight	Issues
Balloons	**8000 lb @ 134 kft**	**Few days**	**Multiple launches**	**450 nm**	**Environment**
Aerostats	**2200 lbs < 15 kft**	**15-30 days**	**Tether**	**150 nm**	**Tether vulnerable**
Airships (Low altitude)	**3000 lbs < 10 kft**	**Few days**	**Maneuverability allows precise location and look angles**	**150 nm**	**Unmanned not demonstrated**

Comparison of Past, Current, and Proposed Airships



Missions for LTA

- **Global war on terrorism:**
  - **Concern about small groups of terrorists acting independently**
  - **Terrorists organizing and executing activities – planting IED's**
  - **Potential for multiple threats, geographically dispersed**
  - **Need for**
    - **Persistent ISR**
    - **Secure communications**
    - **Electronic warfare**
    - **Rapid response and precision kill**

- **ISR for force protection:**
  - **Force protection ashore and afloat**
  - **Unmanned, multisensor electronic surveillance**

Missions for LTA (cont)

- **Communications connectivity**
  - **Longer range comm relay, including in urban environments**
  - **High-bandwidth required for precision situation assessment, targeting, and BDA**
- **Electronic Warfare**
  - **IED countermeasures**
  - **Targeted communications disruption in urban environments**
  - **Defense against cruise missiles**
  - **GPS enhancement for anti-jamming**
- **Cargo Lift/Delivery**
- **Emergency Response for communications and surveillance (DHS)**

Findings

LTA Mission/Vehicle Potential

	ISR	Comm Connectivity	Electronic Warfare	Quick Reaction Weapons	PSYOPS	Cargo Lift/ Delivery
Balloons	Low	Low	None	None	None	Low
Aerostats	High	High	High	None	Medium	None
Low Alt Manned Airships	Medium	Medium	Medium	Medium	Medium	Medium
Low Alt Unmanned Airships	High	High	High	Medium	Medium	Medium
High Alt Airships	High	High	Medium	Low	Low	None
Hybrids	Medium	Medium	Medium	Medium	Medium	High

Aerostats and Low Altitude Airships

Virtues of Low Altitude Aerostats/Airships

- **Both aerostats and airships provide**
  - **Persistence**
  - **Altitude – line of sight**
  - **Reasonably large payload size (antenna)**
  - **Lower costs than UAV's or satellites**
- **Aerostat tether brings power, longer persistence**
- **Airships can relocate for better positioning**

Summary of Aerostat and Airship Costs

LTA Types	Unit Cost System Estimate	Development or Deployment
Aerostats **< 15,000 ft**	**$5M - $6 M**	**Deployment:** **$0.5M - $1.0M (year)**
Manned Airships **low < 10,000 ft**	**$3M -$10M**	**Deployment:** **$1M - $3M (year)**
Unmanned Airships **low < 10,000 ft**	**$3M - $10M**	**$10M -$20M RDT&E**

Note: System costs include: Helium, envelope material, structure (if semi-rigid), sensors (EO/IR, radar, others), tethers (aerostats), ground-handling equipment, ground-control systems (unmanned airships), and approximation of personnel costs. Development costs shown include actuals where programs are completed and ROMs where programs are in development.

Cost/Endurance Comparison for Persistent Surveillance Platforms

Platform	Cost/flight hour	Endurance (unrefueled)
AWACS	$20,000	11 hours
JSTARS	$20,000	11 hours
E-2C	$18,700	4.7 hours
Global Hawk	$26,500	35 hours
Predator	$ 5,000	40 hours
420K TARS	$ 300-500	15-30 days
Airship (Zeppelin)	$ 1,800 (1 yr lease)	Few days

Aerostat/Airship Technical Challenges

- **Station keeping in high winds**
- **Launch, recovery, and operation in foul weather (high winds, icing)**
- **Payload integration**
- **Underway shipboard aerostat operation**
- **Airship power consumption compromises persistence**
- **Survivability of payloads**

Aerostats Conclusions

- **Provide persistence for 15 –30 days**
  - **Persistence reduced by weather**
- **Carry sensors to**

  monitor groups of people
  detect and track low flying aircraft
  detect and track small boats
- **Lower cost option**
- **Provide low cost, persistence surveillance**
  - **Port and harbor security**
  - **ISR for independently operating ships**
- **Extend the horizon**
  - **Communications relay for Marines on the ground**
  - **Communications link for ships operating independently**

Recommendations
Low-Altitude Aerostat

- **Capture lessons learned from use of aerostats in Iraq and Afghanistan**
- **Support Marine Corps Universal Need Statement for aerostat comm relay (MCCDC)**
- **Acquire aerostats to conduct operational experimentation for port/harbor security (CFFC)**
- **Initiate program to develop aerostats for shipboard underway operations**
- **Conduct LTA GPS assurance experiments**

Low-Altitude Airships Conclusions

- **Provide enhanced capabilities for ISR**
  - **can maneuver and track movement**
- **Army experience with aerostats and JLENS development**
  - **Validated need for repositioning of sensors**
  - **Validated need (unfunded) for an unmanned airship**
- **Unmanned airships desired for combat areas**
  - **aircrew vulnerability**

Recommendations: Low-Altitude Airship

- **Support the NAVAIR Advanced Development Program Office (ADPO) dedicated to airship exploratory initiatives—near and far term**
- **Lease or procure an airship to develop and evaluate unmanned naval operation**
- **Pursue a joint ACTD for an unmanned airship with CENTCOM and/or SOCOM and DHS sponsorship**
- **Address survivability issues**
- **Conduct fleet operations to evaluate airships (CFFC)**

High Altitude Airship

High-Altitude Airship (Unmanned)

- **Potential Missions**
  - **ISR (cruise missile defense)**
  - **Communications relay**
  - **GPS assurance and enhancement**
- **Potential Characteristics**
  - **Altitude: > 65,000 ft – increased line of sight**
  - **Endurance: >30 days**
  - **Large aperture antennas**
  - **Possible novel hybrid design**

High-Altitude Airship Status

- **Required capabilities exceed current technology base**
- **DARPA sponsoring ISIS radar (1600 square meter antenna) development**
- **Missile Defense Agency/High Altitude Airship (HAA) is developing a scaled vehicle**
- **Others pursuing high altitude vehicle (Japan, South Korea, Sanswire …)**

High-Altitude Airship S&T Issues

- **Materials (corrosive ozone, ultraviolet radiation, high winds)**
- **Power sources (must be regenerative for mission and propulsion)**
- **Propulsion (station keeping/transit)**
- **Controls**
- **Data load handling**
- **Integration**

High-Altitude Airship (Unmanned) Recommendations

- **Monitor high-altitude airship development but at this time do not allocate S&T funds or other resources to the program.**

- **Leverage the DARPA ISIS S&T program for the development of a low-power-density, large aperture antenna for application in LTA vehicles**

Heavy Lift

Heavy-Lift LTA

Heavy Strategic Lift to Sea Bases and Forces Ashore

- **Current Options:**
  - **Multiple cargo transfers**
  - **Vehicles payload and range limited**

- **LTA Heavy Lift offers potential for direct heavy lift from CONUS to sea bases and forward-deployed ground forces**

- **Significant Technology Development Required**

- **DARPA Walrus to Demonstrate Several Heavy Lift Attributes**

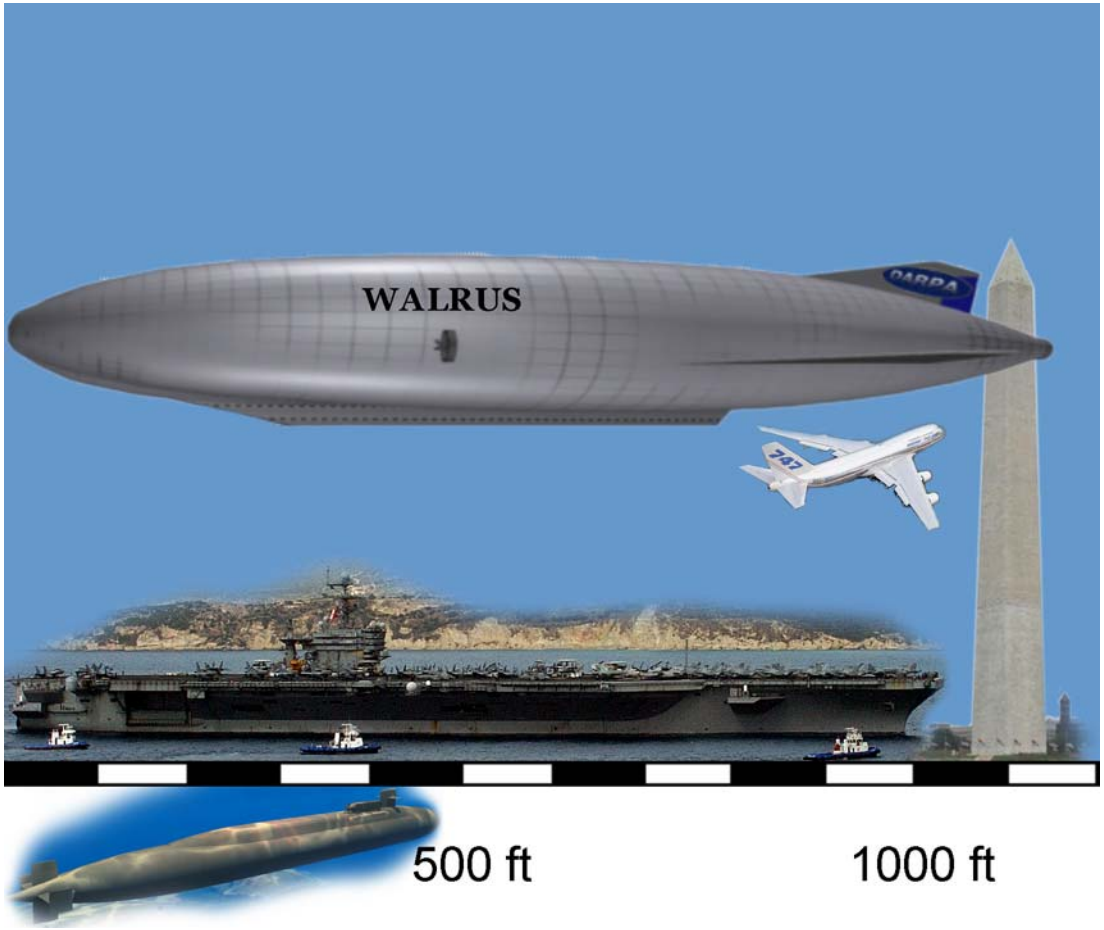
	Demo Phase	Final Goal
IOC	2009	??
Range	2000 nm	12000 nm
Payload	40 Tons	> 500 Tons
Volume	2,500,000 ft3	30,000,000 ft3
Speed	>70 Kts	> 70 Kts
T.O./Lndg/Cargo Ops	??	??

Heavy-Lift LTA Technical Challenges

- **Internal Buoyancy Control**
  - **Fuel Burn/ Helium Degradation**
  - **Off-Loading Compensation**
- **Fabric/Structure Development**
- **Ground/Ship Compatibility During Landing/Takeoff/Rest**
  - **Wind/weather**
  - **Sea state**
  - **Loading/unloading**

Heavy-Lift LTA Systems Are Promising
But
Not Ready for Acquisition

Size Perspective for Walrus



Heavy-Lift LTA Recommendations

- **Assign /establish responsibility for development of relevant CONOPS for heavy-lift LTA program**
- **Monitor and actively engage with Walrus prototype to investigate naval compatibility**
- **Conduct studies to ensure Maritime Prepositioning Force (Future)--MPF(F)--ships are compatible with proposed heavy-lift airship concepts**

Summary

Conclusions

- **The Navy is behind the Marine Corps, Army, Air Force in the use of LTA for military missions.**
- **Aerostats provide affordable persistence for accomplishing Navy-Marine Corps missions:**
  - **force protection ashore**
  - **communications relay**
  - **electronic warfare**
- **Advanced LTA concepts—that require investment--offer promise for greatly enhancing performance**
  - **unmanned airships**
  - **aerostats on underway ships**
- **Advanced LTA concepts-that require significant S&T investment- offer promise for greatly enhancing performance**
  - **high altitude airship**
  - **cargo lift**
- **Current LTA capabilities for heavy lift and high altitude ISR are being oversold**

Summary Recommendations

- **Expand and sustain the existing NAVAIR Advanced Development Program Office (ADPO) to include all naval LTA R&D systems activities—near to far term**
- **Evaluate capability of aerostats for naval port/harbor security and for Marine Corps communications relay**
- **Demonstrate an aerostat for underway shipboard operations—50 knots, sea state 3+**
- **Demonstrate low-altitude, unmanned airship to provide rapid reaction for ISR, communications relay, electronic warfare, mine countermine, and ASW**
- **Leverage the DARPA ISIS S&T program for the development of a low-power-density, large aperture antenna for application in low-altitude LTA vehicles**
- **Explore utility of ONR Advanced Multi-function RF Concept (AMRFC) technology for high-altitude, low-power-density, large aperture LTA radar systems**
- **Conduct studies to understand how the WALRUS prototype vehicle interfaces with future sea-basing concepts, including MPF(F)**

Questions ?